**Practical activity : Date: Class: Student name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Supporting standards:**

|  |  |  |
| --- | --- | --- |
| Foundation | Advanced |  |
| 19.1 | 24.1 | Know, interpret and use the nomenclature… of… esters… |
| 19.11 | 24.11 | Describe… chemistry of alcohols…including… ester formation… |
| 19.14 | 24.14 | Describe… carboxylic acids… reactions to form esters… |
| 19.15 | 24.15 | Describe the characteristic structure of esters and know they can be hydrolysed to the alcohol and acid. |
| 19.16 | 24.16 | Know the main commercial uses of esters in perfumes and flavourings. |

**Esters key facts:**

Refer to your notes and pages 160 and 197 of *Advanced Chemistry for You* for the rules for naming esters.

Complete the table below:

|  |  |
| --- | --- |
| **1** | Esters are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ by dilute acids or bases to form the parent carboxylic acid and alcohol. |
| **2** | Esters are not miscible in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ because they contain no –OH groups. |
| **3** | An ester is made by reacting an alcohol and a carboxylic acid in the presence of \_\_\_\_\_\_\_\_\_\_\_\_\_\_ sulfuric acid. |
| **4** | Example:  CH3OH + CH3COOH A59-2 CH3COOCH3 + H2O  Name of compound: \_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

**Enquiry standards:**

1.8 Identify, and make critical use of, secondary information

3.1 Record raw data appropriately in a manner that allows easy interpretation

**Investigation 14.3 Formation of esters**

Students make esters and separate them from the reaction mixture with sodium carbonate solution.

**Equipment and chemicals required**

glacial acetic acid

ethanol

concentrated sulfuric acid

test tubes

large beaker or water bath

10% sodium carbonate solution

small beaker

Other acid/alcohols combinations, eg

**Odour of ester formed**

ethanol methanoic acid raspberry

octanol acetic acid peach/orange

pentanol (amyl) acetic acid banana

methanol salicylic acid “deep heat” (oil of wintergreen)

isoamyl acetic acid pear

ethanol butanoic acid pineapple

Warning: butanoic acid has a very unpleasant smell: teacher demonstration only!

**Investigation 14.3 Formation of esters**

Carboxylic acids react with alcohols to form esters and water.

**1** To about 1 mL of pure (glacial) ethanoic acid in a test tube, add a drop of concentrated sulfuric acid (as a

catalyst and dehydrating agent) then add about 2 mL of ethanol. Heat the mixture in a beaker of boiling

water for 3 minutes.

**2** Pour the contents of the test tube into a small beaker containing about 20 mL of 10% sodium carbonate

solution.

Observation:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**3** What is the purpose of the sodium carbonate solution?

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**4** Allow the mixture to settle out, then observe the surface of the liquid and smell cautiously.

Describe the smell:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Describe the surface:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**5** Write a word equation for the reaction in **1**.

**6** Esters are not soluble in water: how can we tell?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**7** Repeat steps **1**, **2** and **4** for different pairings of carboxylic acid and alcohols and complete the table below.

**Carboxylic acid used Alcohol used Smell of ester**

A

B

C

**8** Write word equations for the esterification reactions performed in **7** and name each ester formed.

A:

B:

C:

**Investigation 14.3 Formation of esters**

Carboxylic acids react with alcohols to form esters and water.

**1** To about 1 mL of pure (glacial) ethanoic acid in a test tube, add a drop of concentrated sulfuric acid (as a

catalyst and dehydrating agent) then add about 2 mL of ethanol. Heat the mixture in a beaker of boiling

water for 3 minutes.

**2** Pour the contents of the test tube into a small beaker containing about 20 mL of 10% sodium carbnate

solution.

Observation: Solution fizzes and a colourless gas is evolved.

**3** What is the purpose of the sodium carbonate solution? To neutralise excess acid.

**4** Allow the mixture to settle out, then observe the surface of the liquid and smell cautiously.

Describe the smell: ‘Aeroplane glue’

Describe the surface: An oily layer above the aqueous layer.

**5** Write a word equation for the reaction in **1**.

ethanoic acid + ethanol ⭢ ethyl ethanoate

**6** Esters are not soluble in water: how can we tell? The two layers are not miscible.

**7** Repeat steps **1**, **2** and **4** for different pairings of carboxylic acid and alcohols and complete the table below.

**Carboxylic acid used Alcohol used Smell of ester**

A methanoic acid ethanol raspberry

B butanoic acid ethanol pineapple

C salicylic acid methanol ‘Deep heat’

**8** Write word equations for the esterification reactions performed in **7** and name each ester formed.

A: methanoic acid + ethanol ⭢ ethyl methanoate

B: butanoic acid + ethanol ⭢ ethyl butanoate

C: salicylic acid + methanol ⭢ methyl salicylate

|  |  |  |  |
| --- | --- | --- | --- |
| **METHODS OF SCIENTIFIC INVESTIGATION AND RESEARCH** | | | |
|  | Below the standard | Approaching the standard | Meets the standard |
| 1.8 Identify, and make critical use of, secondary information |  |  |  |
| 3.1 Record raw data appropriately in a manner that allows easy interpretation |  |  |  |